PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-283637

(43)Date of publication of application : 12.10.2001

(51)Int.Cl. H01B 1/20
H01B 5/16
H01L 21/60

(21)Application number : 2000-099883

(22)Date of filing : 31.03.2000

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(54) ANISOTROPIC CONDUCTIVE BONDING MATERIAL AND ITS CONNECTING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an anisotropic bonding material for assuring connecting reliability, similar to that in conventional anisotropic conductive connection using a gold bump or a soldering bump, even if a relatively hard bump such as a nickel bump is used for a protruded electrode in anisotropic connection between an electronic element such as a bare IC chip with the protruded electrode and a connection pad for a wiring board.

SOLUTION: For an anisotropic conductive bonding material having conductive particles dispersed in a thermosetting resin, a 10% compression bonding modulus of elasticity (E) of the conductive particles and a vertical modulus of elasticity (E') of the protruded electrode of the electronic element to be connected with the anisotropic conductive bonding material are satisfied with a relational expression, $0.02 \leq E/E' \leq 0.5$.

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]An expression of relations (1) of the following [modulus of longitudinal elasticity / (E') / of a protrusion shaped electrode of an electronic device which should be connected in a charge of an anisotropy electric conduction binder which distributes a conductive particle to thermosetting resin at the 10% compressibility (E) and the charge of an anisotropy electric conduction binder concerned of this conductive particle]
[Equation 1]
$0.02 <= E/E' <= 0.5$ (1)
The charge of an anisotropy electric conduction binder currently ******(ing).
[Claim 2]The charge of an anisotropy electric conduction binder according to claim 1 whose mean particle diameter of this conductive particle is 1-10 micrometers.
[Claim 3]The charge of an anisotropy electric conduction binder according to claim 1 or 2 by which a protrusion shaped electrode of an electronic device is constituted from nickel.
[Claim 4]A charge of an anisotropy electric conduction binder which distributes a conductive particle to thermosetting resin is made to pinch between a protrusion shaped electrode of an electronic device, and a connection pad of a wiring board, in a connection method which connects while securing a flow with an electronic device and a wiring board by carrying out heat pressing of them -- an expression of relations (1) of the following [modulus of longitudinal elasticity / (E') / the 10% compressibility (E) of a conductive particle, and / of a protrusion shaped electrode of an electronic device] as a charge of an anisotropy electric conduction binder
[Equation 2]
$0.02 <= E/E' <= 0.5$ (1)
A connection method using what currently is ******(ing).

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the charge of an anisotropy electric conduction binder, and a connection method.
[0002]
[Description of the Prior Art]In recent years, carrying out flip chip mounting of the raise in basic wages IC chip provided with the gold bump or the solder bump as a protrusion shaped electrode to the electrode pad of the substrate for IC loading directly, or processing and mounting it in the gestalt of a chip-size package (CSP) is performed. In the case of such mounting, putting and carrying out heat pressing of the film state and the paste state or liquefied charge of an anisotropy electric conduction binder which contain thermosetting resin and conductive particles, such as an epoxy resin, between the protrusion shaped electrode of a raise in basic wages IC chip and the substrate for IC loading is performed.
[0003]By the way, in the case of a gold bump, there is a problem that material cost is very expensive. In the case of a solder bump, are manufactured by an electrolytic plating method for the purpose of detailed and uniform bump formation, but. A resist process is not only required, but before performing a solder plate, it forms a substrate metal layer (Ti/Cu) and the problem of requiring the complicated electrolytic plating process of forming a metal barrier composite plating layer (Cu/nickel/Au) is.
[0004]Then, material cost is low and to use the nickel bump which can be formed at a comparatively simple electrolytic plating process is tried.
[0005]
[Problem(s) to be Solved by the Invention]The hardness of a nickel bump compared with a gold bump or a solder bump However, since it is high, The conductive particle in the charge of an anisotropy electric conduction binder was crushed by the nickel bump, and carried out

plastic deformation, and the contact state stable to the nickel bump of a raise in basic wages IC chip and the electrode pad of the substrate for IC loading could not be maintained, but there was a problem that connection reliability fell.

[0006]This invention solves the problem of the above Prior art.

When the purpose carries out anisotropy conductive connection of electronic devices, such as a raise in basic wages IC chip provided with the protrusion shaped electrode, and the connection pad of a wiring board, even if it is a case where comparatively hard vamps, such as a nickel bump, are used as a protrusion shaped electrode, It is providing the charge of an anisotropy electric conduction binder which can secure the connection reliability which is not different from the conventional anisotropy conductive connection which uses a gold bump and a solder bump.

[0007]

[Means for Solving the Problem]This invention persons are closely [connection reliability at the time of anisotropy conductive connection] related in the 10% compressibility (E) of a conductive particle in a charge of an anisotropy electric conduction binder, and a modulus of longitudinal elasticity (E') of a protrusion shaped electrode of an electronic device, And by adjusting a ratio to (E) (E') to a specific range, it finds out that connection reliability may be raised and came to complete this invention.

[0008]Namely, an expression of relations (1) of the following [modulus of longitudinal elasticity / (E') / of a protrusion shaped electrode of an electronic device which should be connected in a charge of an anisotropy electric conduction binder to which this invention distributes a conductive particle to thermosetting resin at the 10% compressibility (E) and the charge of an anisotropy electric conduction binder concerned of this conductive particle]

[0009]

[Equation 3]

$0.02 \leq E/E' \leq 0.5$ (1)

The charge of an anisotropy electric conduction binder currently ******(ing) is provided.

[0010]This invention between the protrusion shaped electrode of an electronic device, and the connection pad of a wiring board, In the connection method which connects while securing a flow with an electronic device and a wiring board by making the charge of an anisotropy electric conduction binder which distributes a conductive particle to thermosetting resin pinch, and carrying out heat pressing of them, The connection method using that with which the modulus of longitudinal elasticity (E') of the protrusion shaped electrode of the 10% compressibility (E) and the electronic device of a conductive particle is filling the above-mentioned expression of relations (1) as a charge of an anisotropy electric conduction binder is provided.

[0011]

[Embodiment of the Invention]Hereafter, this invention is explained in detail.

[0012]The expression of relations (1) of the following [modulus of longitudinal elasticity / (E') / of the protrusion shaped electrode of an electronic device which should be connected by the 10% compressibility (E) and the anisotropic conductive adhesive concerned of a conductive particle although the charge of an anisotropy electric conduction binder of this invention is the film state and the paste state or liquefied charge of a binder which distribute a conductive particle to thermosetting resin]

[0013]

[Equation 4]

$0.02<=E/E'<=0.5$ (1)

To ****** is required. this is because sufficient connection reliability is not securable since the stability of a conductive particle is small if E/E' is less than 0.02, electric conduction particles are not fully crushed, but it is alike too and sufficient connection reliability cannot be secured, if 0.5 is exceeded.

[0014]Here, the modulus of longitudinal elasticity (E') of a protrusion shaped electrode can be measured with the test method based on JIS Z2241. The 10% compressibility (E) of a conductive particle corresponds to the K-value defined as 42 pages of "theories of elasticity" (Tokyo Tosho 1972 issue) like loun DAU Lifshits **********. The meaning of this K-value is as follows.

[0015]h is given by following formula (i) and (ii) when a radius makes it contact in the state where an elastic ball object which is two of R and R', respectively was made to compress.

[0016]

[Equation 5]

$h=F^{2/3}[D^2(1/R+1/R')]^{1/3}$(i)

$D= (3/4) [(1-sigma^2) /E+(1-sigma'^2)/E']$ (ii)

As for R+R', and the difference of the distance of the center to center of both balls and F, in h, elastic-modulus [of two elastic balls], sigma, and sigma' expresses the Poisson's ratio of an elastic ball here, as for compressive force, E, and E'.

[0017]When transposing a ball to the board of a rigid body and compressing from both sides, on the other hand if R'->infinity and E>>E', following formula (iii) will be obtained approximately.

[0018]

[Equation 6]

$F= (2^{1/2}/3) (S^{3/2}) (E-R^{1/2}) (1-sigma^2)$ (iii)

S expresses the amount of compression sets here. A K-value is expressed with formula (v)

when a K-value is defined like formula (iv) here.

[0019]

[Equation 7]

$K=E/(1-\text{sigma}^2)$(iv)

$= [\ K\ ]\ (3/\text{root}2)$ and $F\text{-}S^{-3/2}$ and $R^{-1/2}$(v)

[0020]This K-value expresses spherical hardness universally and quantitatively. By using this K-value (namely, 10% compressibility (E)), it becomes possible to express quantitatively and uniquely a spherulite or the suitable hardness of a spacer (henceforth a spacer etc.). In the example of this specification, the concrete measuring method of a K-value is explained in detail.

[0021]The numerical value of the 10% compressibility (E) of a conductive particle itself, Since there are a danger that a flow cannot be taken by initial connection, and a danger of giving a damage to circuit parts other than a protrusion shaped electrode when a possibility of becoming a faulty connection in a connection reliability examination if too small is high and too large, generally it is referred to as 3 - 30Gpa. The numerical value of the modulus of longitudinal elasticity (E') of the protrusion shaped electrode of an electronic device itself, Since electric conduction particles will slide into a protrusion shaped electrode at the time of connection if too small, there is a danger of becoming a faulty connection, and there is a danger of destroying the circuit electrode by the side of a substrate, etc. when the pressure at the time of connection is high when too large, generally it is referred to as 40 - 200Gpa.

[0022]Although a charge of an anisotropy electric conduction binder of this invention has the above features, it can be made to be the same as that of the conventional charge of an anisotropy electric conduction binder about other composition.

[0023]For example, as thermosetting resin, an epoxy resin, urethane resin, unsaturated polyester resin, etc. can be mentioned. Thermosetting resin may have photoactive functional groups, such as acrylic ester residue and methacrylic-acid-ester residue. Especially, it is preferred to use a solid epoxy resin at ordinary temperature. In this case, a liquefied epoxy resin can also be used together at ordinary temperature. A liquefied rate of a compounding ratio of an epoxy resin to a solid epoxy resin can be suitably determined according to a military requirement to a charge of an anisotropy electric conduction binder made into film state at ordinary temperature. When a flexible grade of a film which consists of the above solid or liquefied epoxy resins is raised more and a charge of an anisotropy electric conduction binder carries out peel strength nearby improvement by that cause, especially a thing for which a flexible epoxy resin is further used together in addition to those epoxy resins is preferred. In this case, since the addition effect of a flexible epoxy resin is not fully acquired when too small, but heat resistance falls in being too large, content of a flexible epoxy resin used for a charge of an anisotropy electric conduction binder of this invention may be 5 to 25 % of the weight

more preferably five to 35% of the weight.

[0024]It can be used choosing suitably so that the above-mentioned formula (1) may be filled out of material which is conventionally used in a charge of an anisotropy electric conduction binder as a conductive particle used in this invention. For example, metal particles, such as a solder particle and a nickel particle, and resin core metallic coating particles by which a metal plating film was formed in the resin core surfaces, such as styrene resin, Inorganic powder, such as silica, is made to adhere to the circumference of a resin core by hybridization, and also a composite particle covered with a metal plating film can be used.

[0025]As for mean particle diameter of a conductive particle, although it can be suitably determined according to a bump material, the Bengbu height, etc. of an electronic device used as a connection object, when carrying out flip chip mounting of the raise in basic wages IC chip by high density, it is preferred to consider it as a size of 1-10 micrometers.

[0026]Although loadings of a conductive particle can be suitably determined according to a front bump product of an electronic device, connection pad area of a wiring board, etc. used as a connection object, Since electric conduction particles will not be put between inter-electrode [up-and-down] if too small, but it becomes defective continuity, and it will become inter-electrode [which adjoins by condensation of electric conduction particles], and a short cause if too large, it is usually preferred to consider it as three to 30 weight section to resin-solid-content 100 weight section of a charge of an anisotropy electric conduction binder of this invention.

[0027]A publicly known additive agent blended with a charge of an anisotropy electric conduction binder of this invention at the conventional charge of an anisotropy electric conduction binder if needed, For example, thermosetting insulating resin of coupling agents, such as an isocyanate cross-linking agent and an epoxysilane compound, epoxy denaturation silicone resin, or phenoxy resin can be added.

[0028]The charge of an anisotropy electric conduction binder of this invention can prepare thermosetting resin and a conductive particle which were mentioned above by mixing uniformly in solvents, such as toluene, if needed. It may be used as [of liquefied or paste state], or membranes can be formed, and it can also be used as a thermosetting anisotropy electric conduction adhesive film.

[0029]A charge of an anisotropy electric conduction binder of this invention between a protrusion shaped electrode of an electronic device, and a connection pad of a wiring board, A charge of an anisotropy electric conduction binder which distributes a conductive particle to thermosetting resin can be made to be able to pinch, and it can apply to an anisotropy conductive connection method which connects while securing a flow with an electronic device and a wiring board by carrying out heat pressing of them preferably.

[0030]An element for which an electronic device has a protrusion shaped electrode is

applicable here. For example, a raise in basic wages IC chip, an LSI chip, etc. are mentioned. as a protrusion shaped electrode, although a gold bump, a solder bump, etc. can be illustrated, and hardness is especially high, a low nickel bump of material cost is used preferably relatively -- things can be carried out.

[0031]

[Example]Hereafter, the following examples of an experiment explain this invention concretely.

[0032]The 10% compressibility (E) (namely, K-value) of the conductive particle was measured so that it might explain below.

[0033](Measuring method of the 10% compressibility (E) of a conductive particle, and a (K-value))

The conductive particle on the steel plate which has a smooth surface is sprinkled, and one conductive particle is chosen from the inside. Next, a granular material compression testing machine (PCT-200 type, the Shimadzu make) is used, A conductive particle is compressed in the smooth end face of a pillar with a diameter [made from a diamond] of 50 micrometers (test force =0.0098N (10grf); compression velocity (constant load speed compression technology) = $2.6x10^{-3}$N (0.27grf) / second; measurement temperature = 20 **). Under the present circumstances, compressive load is electrically detected as electromagnetic force, compression displacement is electrically detected as displacement by an operation transformer, and it asks for the relation of the compression displacement-load shown in drawing 1 (a). It asks for the load value and compression displacement in the 10% compression set of a conductive particle from this figure, respectively, and as shown in drawing 1 (b) from these value and formula (v), not only compressive strain but a K-value (10% compressibility (E)) is calculated. However, compressive strain express with % the value which broke compression displacement by the particle diameter of the conductive particle.

[0034]In the thermosetting insulation bonding agent which mixed example 1 epoxy-resin (Epicoat 1009, product made from Oil recovery Shell Epoxy) 50 weight section, and latent curing agent (HX3721, Asahi Chemical Co., Ltd. make) 45 weight section, The anisotropy electric conduction adhesive film of 35-micrometer thickness was produced by forming what distributed uniformly conductive particle (Nippon Chemical Industrial Co., Ltd. make, mean-particle-diameter [of 6 micrometers], 10% compressibility (E) =41.6GPa) 5 weight section which gold-plated at the spherical nickel particle.

[0035]It is a semiconductor chip (vamp construction material =nickel, bump height = 20 micrometers) about this anisotropy electric conduction adhesive film. Front bump product =10000micrometer^2, modulus-of-longitudinal-elasticity (E') =98GPa, It inserted between E/E'=0.42 and 6.3 mm of outsides **, and a glass epoxy board (quality of a wiring material = Cu, nickel/Au plating, and wiring 18 micrometers in thickness), and both were connected by carrying out heat pressing under conditions of 180 **, 147N (15kgf), and 20 sec. The initial

conduction resistance per one terminal of the obtained connection body was 5-10mohm, and was a good connected state. Although the pressure cooker test (PCT) (121 **, 0.213Mpa (2.1atm), saturated humidity environment) of 100 hours was done to the connection body, there was no big change between the conduction resistance value after PCT and an initial conduction resistance value.

[0036]the electric conduction particles (the Nippon Chemical Industrial Co., Ltd. make.) which gold-plated at the particles of spherical benzoguanamine resin in the thermosetting insulation bonding agent prepared in example 2 Example 1 The anisotropy electric conduction adhesive film of 35-micrometer thickness was produced by forming what distributed uniformly the mean particle diameter of 5 micrometers, 10% compressibility E=4.7GPa, and E/E'=0.0485 weight section. The semiconductor chip and the glass epoxy board were connected like Example 1 using this anisotropy electric conduction adhesive film, and the connection body was obtained. The initial conduction resistance per one terminal of the obtained connection body was 5-10mohm, and was a good connected state. Although the pressure cooker test (PCT) (121 **, 0.213Mpa (2.1atm), saturated humidity environment) of 100 hours was done to the connection body, there was no big change between the conduction resistance value after PCT and an initial conduction resistance value.

[0037]Spherical benzoguanamine resin is covered with silica in the thermosetting insulation bonding agent prepared in example 3 Example 1, The anisotropy electric conduction adhesive film of 35-micrometer thickness was produced by forming what distributed uniformly conductive particle (Nippon Chemical Industrial Co., Ltd. make, mean-particle-diameter [of 7 micrometers], 10% compressibility (E) =21.6GPa, E/E'=0.22) 5 weight section produced by gold-plating at the outside. The semiconductor chip and the glass epoxy board were connected like Example 1 using this anisotropy electric conduction adhesive film, and the connection body was obtained. The initial conduction resistance per one terminal of the obtained connection body was 5-10mohm, and was a good connected state. Although the pressure cooker test (PCT) (121 **, 0.213Mpa (2.1atm), saturated humidity environment) of 100 hours was done to the connection body, there was no big change between the conduction resistance value after PCT and an initial conduction resistance value.

[0038]the conductive particle (the Nippon Chemical Industrial Co., Ltd. make.) which gold-plated at spherical polystyrene resin in the thermosetting insulation bonding agent prepared in comparative example 1 Example 1 The anisotropy electric conduction adhesive film of 35-micrometer thickness was produced by forming what distributed uniformly the mean particle diameter of 5 micrometers, 10% compressibility (E) =1.5GPa, and E/E'=0.0155 weight section. When the semiconductor chip and the glass epoxy board were connected like Example 1 using this anisotropy electric conduction adhesive film, the conductive particle inserted into inter-electrode changed into the state (namely, state which electric conduction particles destroyed)

where it was crushed, but. The initial conduction resistance per one terminal of the obtained connection body was 5-10mohm. However, when the pressure cooker test (PCT) (121 **, 0.213Mpa (2.1atm), saturated humidity environment) of 100 hours was done to the connection body, the conduction resistance after PCT was going up greatly from the initial conduction resistance value, and connection reliability fell greatly.

[0039]It is a semiconductor chip (vamp construction material =) about the anisotropy electric conduction adhesive film produced in comparative example 2 Example 1. [Au and] Bump height = 20 micrometers, front bump product =10000micrometer^2, modulus-of-longitudinal-elasticity (E') =76.4GPa, It inserted between E/E'=0.54 and 6.3 mm of outsides **, and a glass epoxy board (quality of a wiring material = Cu, nickel/Au plating, and wiring 18 micrometers in thickness), and both were connected by carrying out heat pressing under conditions of 180 **, 147N (15kgf), and 20 sec. The initial conduction resistance per one terminal of the obtained connection body was 5-10mohm, and was a good connected state. However, when the pressure cooker test (PCT) (121 **, 0.213Mpa (2.1atm), saturated humidity environment) of 100 hours was done to the connection body, the conduction resistance after PCT was going up greatly from the initial conduction resistance value, and connection reliability fell greatly.

[0040]

[Effect of the Invention]When carrying out anisotropy conductive connection of electronic devices, such as a raise in basic wages IC chip provided with the protrusion shaped electrode, and the connection pad of a wiring board according to the charge of an anisotropy electric conduction binder of this invention, Even if it is a case where comparatively hard vamps, such as a nickel bump, are used as a protrusion shaped electrode, the connection reliability which is not different from the conventional anisotropy conductive connection which uses a gold bump and a solder bump is securable.

[Translation done.]